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Spinal magnetic resonance imaging in cats: differences in clinical significance of intervertebral disk extrusion, intervertebral disk protrusion, and degenerative lumbosacral stenosis

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OBJECTIVE
To determine the occurrence of degenerative changes affecting the vertebral column in cats, assess their clinical significance, and determine the occurrence in cats with intervertebral disk herniation compared to other spinal diseases.

ANIMALS
114 client-owned cats.

METHODS
Hospital records were retrospectively reviewed for cats with suspected myelopathy that had undergone spinal MRI. Signalment; history; neurological examination; neurolocalization; primary diagnosis; presence, type, and location of intervertebral disk herniation; and presence and location of other degenerative spinal changes (intervertebral disk degeneration [IVDD], spondylosis deformans [SD], end plate changes, dorsal compressions [DC], and foraminal stenosis [FS]) were recorded.

RESULTS
70% of cats showed at least 1 spinal degenerative change. The most common change was IVDD, followed by SD and intervertebral disk protrusion (IVDP), while intervertebral disk extrusion (IVDE), end plate changes, DC, and FS were uncommon to rare. Primary complaint was attributed to a degenerative condition in 22% of cats, including 100% with IVDE, 9% with IVDP, and 43% with degenerative lumbosacral stenosis (DLSS). The occurrence of degenerative spinal changes and number of intervertebral disks affected by IVDD significantly increased with age and body weight. Age was positively correlated with the occurrence of SD and DLSS. Intervertebral disk degeneration, IVDP, SD, DC, and FS were more prevalent in the lumbosacral junction. Cats with IVDD were significantly more likely to show IVDE and IVDP.

CLINICAL RELEVANCE
This study revealed that in a population of cats presenting for signs of myelopathy, IVDE was always responsible for the clinical presentation, DLSS was commonly considered incidental, and IVDP was infrequently related to neurological signs.

Keywords: degenerative lumbosacral stenosis, feline myelopathy, intervertebral disk degeneration, intervertebral disk herniation, spondylosis deformans

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Intervertebral disk herniation (IVDH) is a condition seen in 0.12% to 0.44% of cats[1–4] presenting to referral centers.[1,3,5–7] In contrast, a prevalence of 3.5% has been estimated in dogs.[8] Many types of IVDH have been described in cats, including both compressive and noncompressive, but there is conflicting evidence

regarding which is most common.[1–7] One study[1] of clinically relevant IVDH described that intervertebral disk extrusion (IVDE) was more frequently diagnosed than intervertebral disk protrusion (IVDP). In contrast, in a previous cadaveric study[9] performed on general populations of cats, IVDP was described as a common incidental finding.

Degenerative spinal changes other than IVDH include intervertebral disk degeneration (IVDD) of single or multiple disks, spondylosis deformans (SD), hypertrophy of ligaments, articular process changes, and end plate degenerative changes.[10,11] In dogs, these changes are either considered incidental findings or tenuously suggested to cause mild chronic neurological signs or pain,[11–13] or they appear as a component of more complex degenerative conditions such as degenerative lumbosacral stenosis (DLSS).[14]

Radiographic studies[15–18] have evaluated the prevalence of degenerative disease in the vertebral column of asymptomatic cats. However, there is a lack of information in the literature concerning the characterization of these conditions through MRI, either when they occur as the main cause of presentation or when degenerative changes were diagnosed concomitantly to other spinal conditions.

For these reasons, the purposes of this study were as follows: (1) to describe the frequency and character of degenerative spinal changes on MRI in cats presented due to neurologic signs indicating spinal involvement, (2) to compare their occurrence between cats diagnosed with IVDH and cats diagnosed with other spinal diseases, and (3) to assess whether the observed degenerative spinal changes were related to the presenting complaint in this population of cats.

The main hypothesis was that chronic degenerative changes were frequently present in the vertebral column of cats and could be often detected on MRI as an incidental finding. We also hypothesized that cats diagnosed with IVDH would more commonly suffer from other concomitant spinal degenerative changes than cats diagnosed with other types of spinal diseases.

Methods

A retrospective review of medical records from a single hospital (AniCura Ars Veterinaria) was conducted to identify cats presented to the neurology service between September 2017 and December 2022 that showed signs of spinal cord disease and had an MRI performed of at least 1 segment (cervical, thoracic, lumbar, or lumbosacral [LS]) of the vertebral column. Search terms *feline* and *vertebral column* were used in the electronic records from the hospital's MRI service, and medical records for the identified cats were retrieved. Cats were included if (1) signs of spinal pain or neurological deficits consistent with a myelopathy were detected in a neurological examination, which had been performed by a European board-certified neurologist or neurology resident under supervision, and (2) a spinal MRI scan with at least a dorsal STIR sequence, a sagittal T2-weighted (T2W) sequence, and transverse T2W, T2*, and transverse T1-weighted (T1W) sequences was available for review. An informed consent for clinical and research purposes was obtained for all patients at the time of presentation.

The following information was collected from medical records: age at presentation, breed, sex, neuter status, body weight (BW) at presentation, presenting complaint, date of the first observed neurological signs as recalled by the owner, date of diagnosis, general physical and neurological examination findings, clinical neurolocalization, and primary diagnosis (definitive or presumptive). Primary diagnosis was defined as the causative lesion that was considered to explain the presenting neurological signs based on clinical history, neurological examination, and MRI findings. Primary diagnosis could be definitive (eg, an IVDE confirmed at surgery or spinal neoplasia confirmed by biopsy) or presumptive (eg, suspicion of spinal neoplasia based only on MRI findings and additional diagnostic test results, if relevant). If the primary diagnosis was a degenerative condition, then the degenerative spinal change was considered clinically significant. Degenerative changes were considered incidental when they did not produce obvious spinal cord or nerve root compression that could explain spinal pain or neurological deficits, or when other more significant lesions were observed at the same region (eg, neoplasia, vertebral fracture). Inconclusive cases were classified as such when a primary diagnosis could not be reached. If degenerative changes were observed in these cases but were not producing myelopathy or radiculopathy that was clinically considered related to neurological signs, they were classified as incidental. Cases were classified as acute (< 2 weeks from the onset of signs) or chronic (≥ 2 weeks). Neurological examination findings were graded by use of the modified Frankel score[19] (grade 1, spinal hyperesthesia and normal gait; grade 2, ambulatory paraparesis or tetraparesis; grade 3, nonambulatory paraparesis or tetraparesis; grade 4, paraplegia or tetraplegia with intact nociception and possible loss of urinary function; and grade 5, paraplegia with absent nociception and possible loss of urinary function or tetraplegia with respiratory weakness).

All MRI examinations were performed with a conventional 1.5 Tesla scanner (Vantage Elan; Canon Medical Systems Corp) under general anesthesia. The MRI sequence parameters are detailed in **Supplementary Table S1**. Images were reviewed as a group by a neurology resident, a board-certified European Diplomate in Veterinary Neurology, and a board-certified European Diplomate in Diagnostic Imaging, and a consensus was reached. Dorsal STIR, sagittal T2W, and transverse T2W, T2*, and T1W were reviewed. When possible, additional sequences such as transverse STIR, sagittal T1W, and transverse and/or sagittal T1W postcontrast images were also evaluated. The following data were collected from MRI review: (1) presence and location of IVDH and type of disk herniation (IVDP, IVDE, acute noncompressive nucleus pulposus extrusion)[12, 20–23] and (2) presence and location of other degenerative changes in the vertebral column (IVDD, SD, articular process changes

[eg, osteoarthritic changes/articular process hypertrophy, synovial cysts, or hypoplastic articular process], end plate changes [EC; eg, edema, fat alterations, and sclerosis], dorsal compressions [DC; eg, ligamentum flavum hypertrophy or dorsal lamina proliferation], and foraminal stenosis [FS]).[12,23–29] Acute noncompressive nucleus pulposus extrusion was defined as a sudden extrusion of nondegenerated or minimally degenerated nucleus pulposus that caused a spinal cord contusion without compression.[20,21] Hence, it was not considered as a degenerative change. Degenerative LS stenosis was defined as a stenosis at the level of the LS junction produced by degenerative changes.[14] Intervertebral disk protrusion located at the LS junction is usually clinically considered a component of DLSS.[14] Therefore, in this study, the decision was made to classify cats with IVDP affecting the LS junction as suffering from DLSS. Thoracic vertebral canal stenosis (TVCS) was defined as an absolute stenosis of the thoracic vertebral canal produced by various degenerative changes such as IVDP, hypertrophy of the interarcuate ligament, joint capsule, and/or articular facets.[24,26]

All the degenerative changes were compared between anatomical regions and individual intervertebral disks (IVDs) to assess whether certain regions/IVDs were more commonly affected than others. A given spinal region had to be completely examined with MRI to include the case in the comparison of the occurrence of degenerative spinal changes between the 4 regions (C1 through C7, T1 through T13, L1 through L6/L7/L8, LS junction). Cases were excluded if the MRI scan or medical records were not available for review or if imaging quality precluded correct interpretation.

Statistical analysis

Normality of distribution of numerical variables (age, BW, time to diagnosis, and numbers of affected IVDs) was evaluated by inspecting histograms and with the Shapiro-Wilk test. As normality assumption was violated, numerical variables were presented as the median, IQR, and range. Numerical and ordinal variables (modified Frankel score) were compared between unpaired groups by use of the Mann-Whitney *U* test (males vs females, acute vs chronic course, cats with vs without degenerative spinal changes, cats with degenerative spinal changes as a primary disease vs an incidental finding, and cats with primary vs incidental diagnosis of DLSS). Correlation between numerical variables was determined with the Spearman rank correlation coefficient (R_s) and categorized as follows (presented only for positive correlations): R_s > 0.90 to 1.00, very strong; R_s > 0.70 to 0.90, strong; R_s > 0.50 to 0.70, moderate; R_s > 0.30 to 0.50, weak; and R_s = 0.00 to 0.30, negligible correlation.[30] Categorical variables were expressed as counts and proportions of the entire study population or selected groups and compared between groups by use of the maximum likelihood *G* test or the Fisher exact test (if the expected count in any cell of the contingency table was < 5). Odds ratio was used to express the strength of association between categorical variables. The strength of association was categorized as follows (presented only for positive associations): OR > 1 to 2, weak; OR > 2 to 5, moderate; OR > 5 to 10, strong; OR > 10, very strong.[31] The 95% CIs for proportions were calculated by use of the Wilson score method.[32] A significance level (α) was set at .05 in individual comparisons. When the occurrence of several degenerative spinal changes was compared between spinal regions, the Bonferroni correction was applied (α was divided by the number of comparisons) to minimize the risk of family-wise error. All statistical tests were 2-tailed. The statistical analysis was performed in Statistica, version 13.3 (Tibco Software Inc).

Results

Signalment

One hundred thirty-one cats fulfilled the inclusion criteria. Eight cats were excluded from the study because their primary disease turned out to have intracranial location or be of metabolic nature. Four cats were excluded due to incomplete information on the clinical records, 3 cats because no transverse MRI sections were performed, and 2 cats due to low MRI quality that precluded correct interpretation.

Finally, 114 cats were included in the study. The study population consisted of 70 males (61.4%; 64 [91.4%] of them castrated) and 44 females (38.6%; 38 [86.4%] of them spayed). Age ranged from 0.3 to 17.2 years with a median of 6.5 years (IQR, 2 to 11.0 years), with no significant difference between males and females (P = .789). Body weight ranged from 1.3 to 11.3 kg, and males were significantly heavier (median, 5.0 kg; IQR, 3.9 to 6.0 kg) than females (median, 3.7 kg; IQR, 3.3 to 4.5 kg) (P < .001). Seventy-eight (68.4%) were domestic shorthair cats, and 36 (31.6%) were purebreds (Persian and Siamese [7 each], Norwegian Forest Cat [5], Bengal and Maine Coon Cat [4 each], Exotic [2], and Sphynx, British Shorthair, Ragdoll, Chartreux, Russian Blue, Birman, and Abyssinian [1 each]).

Clinical presentation and neurolocalization

The most common presenting complaint was pelvic limb weakness (59/114 cats), followed by inability to walk on the pelvic limbs (32 cats), spinal pain (16 cats), inability to walk in all 4 limbs (2 cats), urinary incontinence (2 cats), 4-limb weakness (1 cat), thoracic limb weakness (1 cat), and tenesmus (1 cat). Findings from the physical examination were otherwise unremarkable in 112 of 114 (98.3%) cats. One cat had hyperthermia and another one a hypovolemic shock.

All cats had a spinal neurolocalization with the following affected segments: T3 through L3 (n = 57), L4 through S3 (50), C1 through C5 (3), and C6 through T2 (4).

Time to diagnosis ranged from 0 to 1,436 days with a median of 26 days (IQR, 5 to 71 days).

Details about the onset of clinical signs were available for 112 of 114 (98.3%) cats. The clinical presentation was acute in 67 of 112 (59.8%) cats and

chronic in the remaining 45 of 112 (40.2%) cats. Severity of neurological signs related to spinal disease ranged from modified Frankel score grades 1 to 5 (21/114 cats were grade 1; 55 cats were grade 2; 19 cats were grade 3; 12 cats were grade 4; and 7 cats were grade 5). The grade was significantly higher in cats with acute course (median grade, 3) when compared to chronic cases (median grade, 2; $P < .001$).

Primary diagnoses

Diagnoses included suspected or confirmed spinal neoplasia (n = 28), traumatic lesions (26), and degenerative spinal diseases (25), followed by inflammatory-infectious (11), inconclusive diagnosis (10), and vascular (5) lesions. In 9 cats, alternative diagnoses were established and included feline hyperesthesia syndrome (n = 4), congenital anomalies (2), syringomyelia (2), and neurodegenerative disease (1). Of 25 cats diagnosed with a degenerative spinal disease as a primary clinical problem, 12 were diagnosed with DLSS, 9 with IVDE, 3 with IVDP, and 1 with TVCS. Final diagnosis was confirmed during surgery in 9 cases of IVDE, 2 cases of IVDP, and 3 cases of DLSS. None of the other degenerative changes observed (SD, EC, DC, and FS) were considered the primary diagnosis, except if they were accompanied by DLSS, IVDE, IVDP, or TVCS. Inconclusive cases were classified as nondegenerative cases.

Frequency of occurrence of spinal degenerative changes

A total of 1,966 IVD spaces were examined in 114 cats, ranging from 7 to 29 IVD spaces per cat (median, 16; IQR, 12 to 21 IVD spaces). At least 1 degenerative spinal change was found in 80 of 114 cats (70.2%; 95% CI, 61.2% to 77.8%). The number of examined IVD spaces did not differ significantly between cats in which degenerative spinal changes were found and those in which they were not found ($P = .525$). In 359 of 1,966 (18.3%) IVD spaces, at least 1 degenerative change was found, ranging from 1 to 25 affected IVD spaces per cat (median, 2; IQR, 1 to 6 IVD spaces). Details are presented in **Table 1**. Cats with degenerative spinal changes were significantly older ($P < .001$) and heavier ($P = .019$) than cats in which no degenerative spinal changes were found, while no sex or breed predisposition for degenerative spinal changes was observed **(Supplementary Table S2)**.

Thirty-one of the 80 (38.8%) cats were affected by only 1 type of degenerative change, and 49 of 80 (61.2%) cats had more than 1 type of degenerative change (2 types in 18 cats, 3 types in 20 cats, 4 types in 9 cats, and 6 types in 2 cats). The numbers of IVD spaces affected by any degenerative spinal change, by IVDD, and by SD were significantly positively correlated with the cat's age (moderate correlation of $R_s = 0.61$, $R_s = 0.61$, and $R_s = 0.51$, respectively; $P < .001$; **Supplementary Figure S1**). The numbers of IVD spaces affected by any degenerative spinal change and by IVDD were also significantly positively correlated with the cat's BW, but both correlations were negligible ($R_s = 0.29$, $P = .002$; and $R_s = 0.26$, $P = .006$, respectively). The number of IVD spaces affected by SD was not significantly correlated with BW ($R_s = 0.16$, $P = .093$).

Degenerative changes by region

The entire cervical region was examined in 19 cats, the entire thoracic region in 34 cats, the lumbar L1 through L6/L7/L8 region in 95 cats, and the LS junction in 95 cats. When cats were analyzed, the occurrence of degenerative spinal changes did not differ significantly between the vertebral column regions **(Supplementary Table S3)**.

When individual IVD spaces were analyzed, IVDD, IVDP, SD, DC, and FS were significantly more prevalent in the LS junction than in other IVD spaces ($P < .001$). On the contrary, EC were significantly more prevalent in the cervical region than in other regions ($P < .001$; **Figure 1; Supplementary Table S4**).

Relationship between IVDH and other degenerative spinal changes

Cats with IVDD were significantly more likely to have IVDE (OR, 12.2; 95% CI, 1.3% to 120%; $P = .025$)

Table 1—The overall occurrence of degenerative spinal changes in the study population of 125 cats.

Degenerative spinal changes diagnosed on MRI scan	No. of cats affected (N = 114)	Frequency of occurrence (95% CI)	No. (%) of IVD spaces affected (N = 1,966)	No. of IVD spaces affected with a particular degenerative change per cat
IVDD	73	64.0% (54.9%–72.3%)	324 (16.5%)	2, 1–6 (1–25)
IVDP	33	29.0% (21.4%–37.9%)	75 (3.8%)	1, 1–3 (1–7)
IVDP cranial to LS junction	23	20.2% (13.8%–28.5%)	55 (2.8%)	2, 1–3 (1–6)
IVDP only in the LS junction	10	8.8% (4.8%–15.4%)	10 (0.5%)	1
IVDP in the LS junction	20	17.5% (11.7%–25.6%)	20 (1.0%)	1
IVDE	9	7.9% (4.2%–14.3%)	9 (0.5%)	1
SD	37	32.5% (24.6%–41.5%)	97 (4.9%)	1, 1–3 (1–9)
EC	3	2.6% (0.9%–7.5%)	9 (0.5%)	1 (1–7)
DC	14	12.3% (7.5%–19.6%)	18 (0.9%)	1 (1–3)
FS	6	5.3% (2.4%–11.0%)	7 (0.4%)	1 (1–2)
Articular changes	0	0%	0	0

DC = Dorsal compressions. EC = End plate changes. FS = Foraminal stenosis. IVD = Intervertebral disk. IVDD = Intervertebral disk degeneration. IVDE = Intervertebral disk extrusion. IVDP = Intervertebral disk protrusion. LS = Lumbosacral. N = Total number of cats or IVDs. SD = Spondylosis deformans.

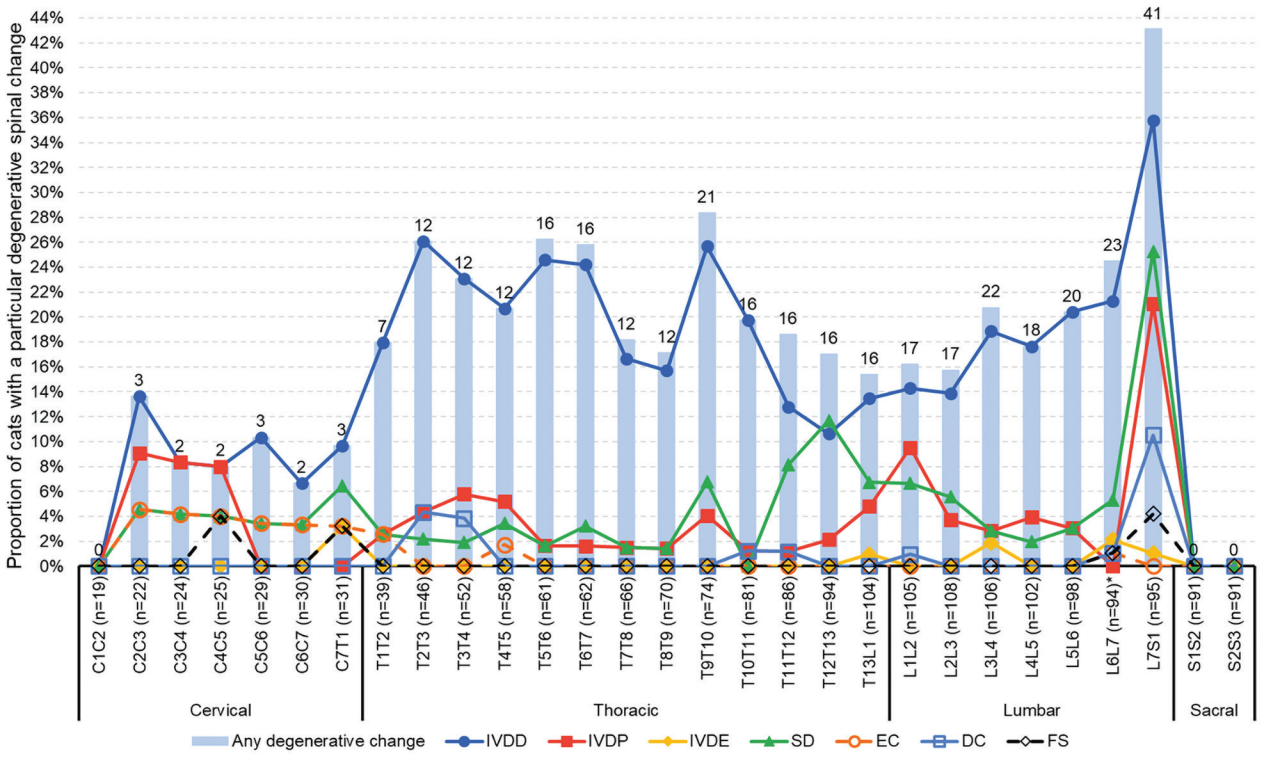

Figure 1—Occurrence of degenerative spinal changes in each intervertebral disk (IVD) space calculated as a percentage of cats in which a given IVD was affected by the number (n) of cats in which a given IVD was examined. Bars show the overall prevalence of any degenerative change in a given IVD, and the numbers above bars are the numbers of cats in which a given IVD was affected by any degenerative change. One cat had 6 lumbar vertebrae (asterisk). DC = Dorsal compressions. EC = End plate changes. FS = Foraminal stenosis. IVDD = Intervertebral disk degeneration. IVDE = Intervertebral disk extrusion. IVDP = Intervertebral disk protrusion. LS = Lumbosacral. SD = Spondylosis deformans.

and IVDP in the cervical, thoracic, or lumbar L1 through L6/L7/L8 region (OR, 10.9; 95% CI, 1.4% to 87.6%; *P* = .003). Both associations were very strong. No other significant associations were observed between the occurrence of IVDH and other degenerative spinal changes.

Relationship between degenerative spinal changes and primary diagnosis

Degenerative spinal changes were considered the primary diagnosis in 25 of 114 cats (21.9%; 95% CI, 15.3% to 30.4%). Hence, 25 of 80 (31.3%) cats in which degenerative changes were observed on MRI scan of the vertebral column had a primary diagnosis of a degenerative spinal disease, and in 55 of 80 (68.7%) cats, degenerative changes were considered an incidental finding. Neither the number of IVD spaces examined (*P* = .731) nor any demographic characteristics differed between these 2 groups of cats **(Supplementary Table S5)**. However, the number of IVD spaces affected by degenerative changes was significantly higher in cats with a primary diagnosis of degenerative spinal disease (median, 6; IQR, 2 to 9 IVD spaces) than in cats with incidental degenerative changes (median, 2; IQR, 1 to 4 IVD spaces; *P* < .001). The occurrence of individual primary degenerative spinal diseases in the study population was as follows: DLSS, 10.5% (12/114 cats; 95% CI, 6.1% to 17.5%); IVDE, 7.9% (9/114 cats; 95% CI, 4.2% to 14.3%); IVDP, 2.6% (3/114 cats; 95% CI, 0.9% to 7.5%); and TVCS, 0.9% (1/114 cats; 95% CI, 0.2% to 4.8%).

Primary complaint was attributed to IVDP in 3 of 23 (13%) cases in which it was detected between C2-C3 and L6-L7 (or the IVD space immediately cranial to the LS junction) and was attributed to an incidental finding in the remaining 20 cats. The 3 cats with primary IVDP showed multiple sites of IVDP (in 2, 4, and 5 IVDs) and IVDD (in 6, 9, and 25 IVDs).

In all 9 cats with IVDE, the presence of IVDE explained the main complaint. Of these, 8 cats showed multiple sites of IVDD (from 2 to 14 IVDs) and 4 cats also showed at least 1 IVDP in a different location (1 IVD in 2 cats, 3 and 7 IVDs in 2 other cats). All 9 cats with IVDE and 2 of 3 cats with primary diagnosis of IVDP underwent decompressive spinal surgery, which confirmed the MRI diagnosis.

Forty-one cats showed degenerative changes in the LS junction. In 28 of them (68.3%), vertebral canal or FS was present due to either IVDP, DC, or both, and these cats were classified as suffering from DLSS. Twelve of these 28 (42.9%) cats had a primary diagnosis of DLSS, and in 16 of 28 (57.1%) cats, DLSS was considered incidental. There were no significant differences in age or other demographic characteristics between cats with a primary diagnosis of DLSS and cats in which DLSS was considered incidental,

and the occurrence of individual degenerative spinal changes was similar in both groups; IVDD, IVDP, and SD were common, and others were occasional **(Supplementary Table S6)**. Cats with DLSS were significantly older (median, 11.3; IQR, 7.0 to 14.0 years) than cats with other degenerative spinal changes (median, 7.6; IQR, 3.5 to 10.8 years; $P = .027$).

Only 1 cat was diagnosed with TVCS at the level of T2 through T4 . Multiple degenerative changes were observed affecting both T2-3 and T3-4 IVD spaces, including IVDD, SD, IVDP, and DC. Multiple degenerative changes were also present in other IVDs in this cat: IVDD in 13 IVDs, SD in 7 IVDs, and IVDP in 1 IVD.

Discussion

This retrospective study describes the occurrence and clinical significance of degenerative spinal changes in cats undergoing spinal MRI for various conditions in a referral veterinary hospital. Our findings document that degenerative spinal changes are common in the population of cats presenting with suspected spinal cord disease, with approximately two-thirds of them exhibiting at least 1 degenerative change in the spine. Despite this, only one-fifth of these cats were suspected to have a degenerative spinal disease process to account for their primary cause of presentation.

As previously reported,[17,18] cats with degenerative spinal changes in our study were older than cats without any degenerative spinal change. Moreover, the number of IVD spaces affected by any degenerative change was significantly correlated with the cat's age, in accordance with previous studies.[3,17,18,33] The number of IVDs affected by IVDD was also correlated with age, which is in accordance with studies[8,34] of dogs.

The most common degenerative change in our study was IVDD, with 62% of cats showing at least 1 site of IVDD and a median of 2 sites of IVDD per cat. Historically, the assessment of degenerative spinal changes including IVDD relied on the evaluation of osteophytes, SD, EC, IVD narrowing, and nucleus pulposus mineralization through radiographic studies, and the prevalences of all these degenerative changes varied between 0.46% and 4.4% in the general population.[17,18] As MRI is the most sensitive tool for detecting IVDD[35] and our study population was not a general feline population but a population of cats with suspected spinal disease, considerably higher occurrence of IVDD in our study is not surprising. Another recent study[7] of thoracolumbar and LS IVDH in cats also reported a 49% prevalence of concurrent IVDD.

Degenerative spinal conditions that were clinically considered the reason for presentation in our study included IVDE, IVDP, DLSS, and TVCS. Thirty-three of 114 (29%) cats suffered from 1 or more site of IVDP. In 23 cats, the IVDP was located cranial to the LS junction. Clinical significance of IVDP in that location was low, with only 3 of 23 cats having a final primary diagnosis of IVDP. Hence, in 30 of 33 cases with IVDP, it was considered an incidental finding. The fact that IVDP may cause only mild chronic neurological signs has largely been described in dogs.[11–13] King and Smith[36] reported that IVDP is a frequent finding during necropsy in cats, without having any clinical relevance. Conversely, more recent literature[1,3,5,7] focusing on clinically relevant IVDP in cats reported low prevalence of this condition. The common occurrence of IVDP as an incidental finding could be explained by different factors, including gradual development of spinal cord compression leading to mild neurological signs or nonspecific clinical signs[1–3] (such as difficulty jumping, inappropriate elimination, decreased grooming, or constipation) that can be easily attributed to natural aging or other degenerative joint diseases.[18,37] In addition, assessing spinal pain of cats can be challenging for veterinarians, and cats' caregivers may hesitate to consent to an MRI scan unless the symptoms severely affect the cat's quality of life. Nevertheless, our findings should increase the clinician awareness that IVDP may not be associated with any obvious or concerning clinical signs in cats.

Almost half of the cats with IVDP (16/33) had multiple IVDs affected. This is most likely an underestimation, as most cases did not have the complete vertebral column examined. Previous studies[3,7] also reported a significant relationship between IVDP and multiple lesions compared to other types of IVDH. In dogs, multiple sites of IVDP are common, usually affecting geriatric patients with mild and progressive clinical signs.[11,38] Interestingly, in our study, all 3 cats with a diagnosis of a clinically significant IVDP suffered from multiple sites of IVDP, although no significant conclusions could be made due to the low number of cases. Studies including a larger number of cases should be conducted to further investigate the relationship between IVDP and other spinal degenerative changes.

The LS junction was evaluated in 95 cats. Over one-third of them showed at least 1 degenerative change, and in most of these cases, vertebral canal stenosis due to IVDP, DC, FS, or their combinations was present. Degenerative LS stenosis is infrequently reported in the literature and is mainly documented through case reports and case series[3,4,7,33,39,40] extracted from referral centers. In the present study, 12 of 28 (43%) cats showing LS vertebral canal stenosis in the MRI had a primary diagnosis of DLSS. This indicates that, as in dogs and humans, degenerative changes observed in the LS junction may be frequently incidental.[14,40] However, it is likely that some of the cats showed some degree of clinical signs related to DLSS yet were not presented for this condition. A previous study[37] suggests a significant correlation between spondylosis in the LS region and behavioral changes in cats, potentially indicating pain. However, the study lacks advanced imaging to further characterize the disease. As discussed for IVDP at other vertebral localizations, the chronic progression of DLSS, especially in older cats, may affect the decision to consent to advanced imaging.

A single IVDE was observed in 9 cats. In contrast to IVDP, IVDE was considered the reason for presentation in all cases. This is most likely because IVDE occurs acutely and is commonly associated with severe neurological signs,[1] which probably makes caregivers more eager to consent to imaging tests. Four of 9 cats diagnosed with IVDE had concurrent IVDP at different IVD spaces. In dogs, a previous cadaveric study[34] reported the occurrence of concomitant chronic, mild, and possibly asymptomatic IVDE. Moreover, multiple sites of IVDE in different IVD spaces is commonly encountered in the clinical setting, especially in chondrodystrophic dogs. It is currently unknown whether this occurs in cats, although in our study, none of the cats diagnosed with other spinal conditions showed imaging findings consistent with chronic IVDE or showed multiple sites of IVDE.

Spondylosis deformans was detected in one-third of cats (37/114) in our study compared to 15% to 80% previously reported.[17,19,37] These large discrepancies could be due to animals' age[17,37] and imaging modality (radiography vs MRI). In our study, SD was associated with IVDP in the same IVD space in roughly half of the cases, with no statistically significant association between the presence of SD and IVDP or IVDE. Previous studies[17,18,19,37] of SD or axial degenerative joint disease in cats rely on noncontrast radiography, precluding any conclusions about the relationship with IVDH. As expected, none of the cats were diagnosed with SD as the primary cause of spinal disease.

Limitations of this study were mostly related to its retrospective nature. First, the frequency of the occurrence of degenerative changes was likely underestimated, mainly because MRI of the entire vertebral column was not performed in most cats. Prospective studies including the complete vertebral column would be necessary to assess the occurrence of degenerative changes more reliably. However, in the clinical setting, the imaging region is generally limited to the area of neurolocalization. To partially overcome this issue when evaluating the location of degenerative change predisposition, only those cases with complete individual spinal regions were included in the statistical analysis. Moreover, bone degenerative changes, such as SD, articular hypertrophy leading to DC, and FS, are less apparent on MRI than on CT; therefore, it is possible that some subtle changes were overlooked in our study, contributing to underscoring their estimated occurrence. Furthermore, MRI sequences were reviewed by the 3 observers at the same time, and analysis of intra- and interobserver agreement was not performed. Another limitation, related to the retrospective nature of the study, was that some of the degenerative changes classified as incidental findings could have had some clinical significance but were not included in the medical history due to failure to recognize more subtle signs. Conversely, it cannot be completely ruled out that in some cases where a degenerative disease was diagnosed, an unidentified lesion may have actually been causing the clinical signs. Chronic pain and mild neurologic signs may be difficult to recognize in cats or may be attributed to advanced age or other degenerative joint diseases.

In conclusion, this study revealed a high occurrence of degenerative changes in the vertebral column of cats presented to the neurology service with suspected spinal cord disease. Most cats suffering from IVDP presented due to other spinal conditions, suggesting that the clinical relevance of IVDP is generally low. Degenerative LS stenosis was also considered an incidental finding in more than half of the cats in which it was observed. Conversely, IVDE explained the presenting complaint in all cats. Our findings should increase clinician awareness that IVDP and DLSS might not be associated with the reason for consultation in cats presenting with signs of myelopathy.

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Supplementary Materials

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